2.5 Human Factors and Aviation Medicine Program Area Description

Mission

The Human Factors and Aviation Medicine Program will use:

- *Applied research*

    To identify methods that, when implemented, contribute to the goal of reducing the fatal accident rate by 80 percent, and

    To develop enhanced guidelines for protective equipment and procedures, and provide recommendations for FAA regulatory and medical certification personnel to enhance safety of aircraft crewmembers and aircraft cabin occupants.

- *Innovative research and management initiatives*

    To ensure that human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications.

The rapid evolution toward increased operational demand, diversity of aircraft and systems, changing technology, and globalization of the airline/ aircraft industry challenges the Human Factors and Aviation Medicine Offices to meet these goals by:

- Ensuring that research is focused on those areas directly impacting aviation safety.

- Capitalizing on opportunities to leverage government and industry resources.

- Forming partnerships with research and university laboratories in order to rapidly transfer the results of research to the aviation community.

- Undertaking major efforts to ensure that human factors expertise is represented across functional disciplines and that human factors considerations are addressed throughout the FAA acquisition process.

Intended Outcomes

The Human Factors Research Program:

Human factors research is increasing the safety and efficiency of the NAS by developing scientifically validated information and guidance for improving the performance and productivity of air carrier crews, general aviation pilots, aviation maintenance and inspection personnel, air traffic controllers, and NAS system maintenance technicians. This program directly responds to FAA Strategic Plan goals to "eliminate accidents and incidents caused by human error" and to "implement new decision support systems and associated functional improvements that fully account for the proper role of people in the system." This research also provides human factors support that addresses the FAA goal to "reduce the costs of flying by making the air traffic management system more efficient to use."

Human factors research is developing human-centered flight controls and displays, and is increasing consideration of human factors in aircrew training. This research also explores prospects for safety enhancement through automated statistical analysis of flight-recorded data and through application of human factors in certification of new aircraft and equipment design and modification.

In aviation maintenance, human factors research develops more effective methods for maintenance technician and inspector training, and improves aviation maintenance technician and inspector task performance. Aviation maintenance human factors research efforts are exploring the application of human factors interventions to improve aviation inspection performance, evaluating the effects of Maintenance Resource Management, and examining human error risk analyses in aviation maintenance and flightline operations. Research is also producing programs used for improving aviation maintenance and inspector team communication to prevent shift change communication errors.

In general aviation, safety is enhanced through the application of human-centered principles to the development of advanced displays and controls and to procedures that improve pilot decision making and performance.

In air traffic control, human factors research will guide the development of human-centered automation and procedures to enhance controller decision making and to reduce error prone conditions. These efforts will also guide the development of tools and procedures to support the collaborative decision making required in the future NAS. An improved approach to classifying human factors associated with operational errors/incidents will result in recommendations for decreasing the frequency of those events.

Aviation Medicine research improves the health, safety, and survivability of aircraft passengers and aircrews through its identification of human failure modes and development of formal recommendations for counteracting human failure conditions. Through this research, the FAA develops bioaeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments as a basis for regulatory action to enhance appropriate human performance. New medical criteria, standards, and assessment/certification procedures are also developed to ensure full performance capability. By assessing flight attendant and passenger behavior and disease issues, guidelines will be proposed for actions to improve the health and safety of cabin occupants.

Program Area Outputs

The Human Factors Research Program:

- Identifies operational needs and problems involving human performance.

- Funds and guides research projects to address operational priorities.

- Forms partnerships with industry and academia.

- Elicits participation by the Nation's top scientists and professionals.

- Provides Human Factors guidance to the FAA for development and implementation of new technologies, training and procedures.

- Facilitates transfer of research products to the operational community.

- Produces data and other forms of information which support notices and regulations applicable to aircraft occupant health and safety.

- Develops output options to solve a public demand (e.g., better restraints for children in aircraft settings); and assesses disease transfer and other aircraft occupant health factors.

The FAA is concerned with ensuring the safety and efficiency of NAS operations, a critical element of which is operator performance. Through guidelines, handbooks, advisory circulars, rules, and regulations, the agency provides industry with human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. The human factors program does the research which provides the technical information necessary to generate these products and services.

Automation has been cited as a contributing factor in aircraft accidents (e.g. Cali: AA965). Human factors research is examining flight deck automation design, operation, and use, and has developed a prioritized research agenda of issues to be addressed. Air carrier training initiatives such as the Model Advanced Qualification Program (air carrier pilot training program which integrates both technical and crew resource management performance requirements) will allow air carriers to develop and utilize proficiency-based training. The Automated Performance Measuring System will provide airlines the ability to analyze routine operations for dangerous trends and tendencies, and will provide insight into the details of daily carrier line operations.

Aviation maintenance research is developing and validating job aids for maintenance documentation. Validated pre-hire assessments for air traffic controllers, electronics technicians, and transportation system specialists will enable the FAA to select persons with appropriate knowledge, skills, and abilities for each occupation, thus reducing training required after employment as well as attrition due to poor person-job fit. Human factors assessments will be conducted to evaluate the performance and safety gains associated with automated decision aids in air traffic control.

The Aviation Medicine Office and the National Institute for Occupational Safety and Health (NIOSH) are examining cabin air quality issues and their effect on passengers and crew. Aviation Medicine is also developing bioengineering crite-

ria to support aircraft seat and restraint system certification, human performance and ergonomic data to support emergency evacuation regulations and standards, biomedical criteria to support protective breathing equipment and operational procedures certification, and biochemical and toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits.

Program Area Structure

The programs address operational requirements through research in the technical thrust areas agreed to by the FAA, NASA, and DOD in the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*.

Human-Centered Automation — This research focuses on the role of the operator and the cognitive and behavioral effects of using automation to assist humans in accomplishing their assigned tasks. The research in this area addresses the identification and application of knowledge concerning the relative strengths and limitations of humans in an automated environment. It investigates the implications of computer-based technology in the design, evaluation, and certification of controls, displays, and advanced systems.

Selection and Training — Research in this area strives to understand the relationship between human abilities and aviation task performance; enhances the measures and methods for the prediction of current and future job/task performance; establishes a scientific basis for the design of training programs, devices, and aids for individuals and teams; defines criteria for assessing future training requirements; and identifies new ways to select aviation system personnel.

Human Performance Assessment — Research in this area identifies intrinsic cognitive and decision making factors for individuals and teams which determine how well they are able to perform aviation tasks; characterizes the impact of environmental and individual factors on human performance; and improves and standardizes methods for measuring human performance.

Information Management and Display — Research in this area addresses the presentation and transfer of information among components in the NAS. It seeks to identify the most efficient and reliable ways to display and exchange information; determines what, when, and how one might best display and transfer information to system components; designs a system to reduce the frequency of information transfer errors and misinterpretations; and strives to minimize the impact when such errors do occur.

Bioaeronautics: Research in this area involves the bioengineering, biomedicine, and biochemistry associated with performance and safety. The objective is enhancement of personal performance and safety by maximizing crew and passenger protection, health, and physiological integrity. The program consists of three research initiatives:

1) Human protection and survival.

2) Medical and toxicological factors in accident investigation.

3) Support for aeromedical certification and inflight aeromedical applications through aviation medicine program support.

Protecting humans in decelerative environments, protective breathing equipment, cabin evacuation, and water survival are investigated in the human protection and survival initiative. Toxicological assessment and sudden or subtle pilot incapacitation are key features of the accident investigation initiative. A program to survey the nature of inflight medical emergencies, particularly the effectiveness of defibrillators carried on airlines, new vision corrective methods for aviation personnel, aircraft cabin environmental hazards, air ambulance medical requirements, and development of protocols for safe use of lasers in laser light shows to prevent incapacitation of pilots, represent current investigations under the aviation medicine program support initiative.

Customer/Stakeholder Involvement

The Human Factors Research Program:

The program directly supports a number of aviation community initiatives and Congressional mandates:

• FAA Strategic Plan Mission Goal for Safety: By 2007, reduce the US aviation fatal accident rate by 80% from 1996 levels. FAA will work with the aerospace community to:

  – Build on currently successful efforts to identify root causes of past accidents

  – Use a more proactive analytical approach, with new data sources, to identify key risk factors and intervene to prevent potential causes of future accidents

  – Study issues and technologies—in partnership with NASA, DOD, and other public and private organizations—to improve policies, procedures, and equipment.

- Office of the Associate Administrator for Research and Acquisitions Performance Plan, Goal 1 ("Contribute to the FAA goal to reduce the fatal aviation accident rate by 80 percent by 2007 as compared to 1994-1996 baseline data), and Goal 2 ("Ensure that human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications).

- Safer Skies — A Focused Agenda, will use the latest technology to help analyze US and global data to find the root causes of accidents and determine the best actions to break the chain of events that lead to accidents.

- *The National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*, published in March 1995, with FAA, NASA, and DOD as signatories. This document, which had extensive aviation community participation in its development, outlines a coherent national agenda for human factors and bioaeronautical research and application leading to significant improvements in NAS safety and efficiency.

- The Aviation Safety Plan is supported through research addressing priority issues associated with crew training, collection and use of safety data, application of emerging technologies, and aircraft maintenance procedures and inspection. The Aviation Medicine program significantly contributes to the application of emerging technologies, as highlighted in the Plan.

- Implementation of the FAA report on "The Interfaces between Flight Crews and Modern Flight Deck Systems."

- Public Law 100-591, which establishes requirements for human factors research and its application as well as the Aviation Medicine Program to conduct research in (A) protection and survival of aircraft occupants; (B) medical accident investigation and airman medical certification; (C) toxicology and the effects of drugs on human performance; and (D) the impact of disease and disability on human performance.; the FY 1998 Department of Transportation Appropriations Act, which cites human factors as the greatest cause of aviation accidents and calls for high priority research; and The Aviation Safety Research Act of 1988, which requires that human factors research be conducted to "enhance air traffic controller performance, develop a human factors analysis of the hazards associated with new technologies, identify innovative and effective corrective measures for human errors, and develop dynamic simulation models of the ATC system."

- The RTCA "Free Flight Action Plan" specifically addresses recommendations to: establish more flexible decision support systems involving collaborative decision making; conduct human-in-the-loop simulations for assessing controller and pilot perceptions of hazards, risks, and discomfort; measure performance, workload, and situation awareness associated with controller and pilot responses to time and distance; conduct real-time human-in-the-loop simulations to systematically study controller and pilot behaviors, interactions, and effects within NAS environments that represent dynamic densities and sector configurations anticipated for free flight.

- Airline and aviation maintenance organizations provide access to their personnel and facilities to permit on-site, realistic research. These organizations have benefited from research products such as electronic job aids, intelligent tutoring systems, guidance on work site environmental conditions, shift-work studies, and advanced training methods.

- The Aviation Medicine Program is responsible under DOT Order 8020.11A, Chapter.4, Paragraph 170 for conduct of toxicological analyses on specimens from, and special

pathologic studies on, aircraft accident fatalities.

- DOT Order 1100.2C, Chapter 53, Paragraph 53-15 requires that the Aviation Medicine Program investigate selected general aviation and air carrier accidents and search for biomedical clinical causes of accidents, including evidence of disease and chemical abuse.

- National Transportation Safety Board Safety Recommendations A-84-93 request the FAA establish at the Civil Aeromedical Institute the capability to perform state-of-the-art toxicological tests on the blood, urine, and tissue of pilots involved in fatal accidents to determine the levels of both licit and illicit drugs at both the therapeutic and abnormal levels.

- The Aviation Medicine Program is an integral participant and research provider under the FAA, Joint Aviation Authorities, and the Transport Canada Aviation Aircraft Cabin Safety Research Plan (established in 1995) which sets forth long-term research goals and ensures coordination between international aviation agencies. Programs within Aviation Medicine which study aircraft cabin environmental quality, and the nature and extent of in-flight medical emergencies are a direct result of specific Congressional mandates to study these topics.

Accomplishments

The Human Factors Research Program:

- Developed and field tested with several airlines a prototype Automated Performance Measurement System (APMS) which allows for gathering and analysis of data from aircraft flight data recorders. This information and analysis capability is utilized by the Flight Operations Quality Assurance program, a joint FAA and airline venture to enhance aviation safety.

- Validated use of simulator parameters and flight data for evaluating Advanced Qualification Program (AQP) effectiveness.

- Developed a model Advanced Qualification Program (AQP) for use by training centers to support regional air carrier participation in AQP, a proficiency-based approach to pilot training.

- Developed error mitigation training for cockpit crews.

- Developed human factors guidelines for air carrier use in constructing operating documents.

- Provided Crew Resource Management procedure guidelines for regional airlines.

- Validated human performance transfer functions for level B full flight simulators.

- Developed preliminary training guidelines for cockpit distractions and interruptions.

- Produced and presented the FAA Human Factors Course to increase understanding of the importance of considering the "human factor" in design/acquisition of FAA systems.

- Produced and distributed a handbook for Advanced Crew Resource Management training.

- Completed a study of the effectiveness of delivering technical information to line aircraft technicians using wireless, portable, pen-based computers that display technical publications.

- Initiated process to integrate shift-change error identification and mitigation processes into the aircraft maintenance error-detection and reporting system.

- Identified and documented best practices for engine non-destructive inspections and testing.

- Developed a process to improve work documentation in repair stations.

- Developed automated system of self instruction for specialized maintenance training.

- Developed pilot performance data through flight simulation for use in establishing certification standards for general aviation autonavigation and control systems.

- Completed human factors assessments of advanced controls and displays for the Advanced General Aviation Transport Experiment aircraft. Provided recommendations to guide certification of those devices

- Completed evaluation and recommendations for using PC-based aviation training devices in pilot instrument flight training

- Developed SATORI, a computerized system to graphically re-create ATC incidents in en route air traffic control. The technology has been transferred to each of the CONUS en route centers, the William J. Hughes Technical Center, regional offices, and headquarters.

- Validated and approved a new computerized test battery (AT-SAT) for operational use in selecting air traffic controllers.

- Validated the Basic Electronics Screening Tool for operational use in selecting electronics personnel.

- Directed a large-scale effort to identify and resolve a large number of human factors issues inherent in the STARS display.

- Sponsored the National Research Council's assessment of human factors issues in the air traffic control system and the publications entitled *Flight to the Future - Human Factors in Air Traffic Control* and *The Future of Air Traffic Control.*

- Conducted a human/system performance assessment of the Departure Sequencing Engineering Development Model.

- Completed a human factors audit of the Converging Runway Display Aid (CRDA) installed at St. Louis Airport. CRDA is a decision support tool that helps terminal radar controllers efficiently space aircraft arriving on separate, converging runways.

- Completed measurement of taskload and documented work processes of personnel at maintenance control centers.

- Developed guidelines to reduce in-flight sudden/subtle incapacitation.

- Evaluated autopsy data from fatal aviation accidents to recommend protective equipment and design practices.

- Assessed flight attendant reproductive health hazards.

- Reported on the suitability of component tests for showing regulatory compliance with crashworthiness standards for aircraft.

- Completed definitive evacuation escape slide angle and strength studies to minimize escape injuries and escape failures.

- Developed fit and comfort standards for aviation oxygen mask systems.

- Assessed operational hazards of in-flight laser exposure.

- Completed a study of DNA probes used in the identification of postmortem ethanol.

R&D Partnerships

The Human Factors Research Program:

The Human Factors Program is linked to NASA and DOD under the auspices of the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*. Specific areas of coordinated program execution with NASA include cockpit automation, fatigue, crew resource management, team decision making, air-ground communication, and the Automated Performance Measurement System. DOD joint efforts involve fatigue, team performance, and decision making research. Additionally, the Human Factors Office maintains a membership in the DOD Human Factors Engineering Technical Advisory Group which provides a forum for the coordination of research across a variety of technical areas.

The Human Factors Office participates with the Netherlands National Research Laboratory in flight deck automation and air/ground integration research. The Office maintains an active membership on all Society of Automotive Engineering G-10 Human Factors subcommittees related to ongoing and future research areas to ensure transition of the results to standards and guidelines. Members from the National Transportation Safety Board work with the Human Factors Office in the areas of fatigue, flight deck automation, and error mitigation.

The Human Factors Office places grants with universities supporting research on air carrier training, flight deck automation, general aviation, and aviation maintenance technician training and air traffic/airway facilities. Coordinated research efforts are conducted with NASA Ames in free flight. An Interagency Agreement with the US Navy Air Warfare Center focuses on development

of training and performance measurement strategies to enhance teamwork in both flight deck crews and air traffic control teams. Special attention is being paid to training enhancements that develop aviation teamwork skills and the utility of advanced technologies for delivering team training. Additionally, elements of the controller performance research project are conducted in concert with the U.S. Air Force's Armstrong Laboratory. Finally, collaborative research in shift work and fatigue is conducted with the US Coast Guard Research and Development Center.

The Aviation Medicine Research Program:

The Office of Aviation Medicine collaborates with NIOSH on a study addressing the cabin environment and flight attendant and passenger symptomatology and diseases. In addition, a liaison is maintained with the American Society of Heating, Refrigeration, and Air Conditioning Engineers Committee addressing aircraft cabin air quality status and research.

The Office of Aviation Medicine maintains direct cooperative research processes with all the manufacturers responsible for safety products (seats, restraint systems, oxygen masks, evacuation slides, etc.). The Office of Aviation Medicine is also represented on appropriate subgroups of organizations such as the Aerospace Medical Association, the Society of Automotive Engineers, the Civil Aviation Medical Association, and the Professional Aeromedical Transport Association. Appropriate liaison with the military is maintained either through direct project collaboration (e.g., crashworthiness, eye injury from lasers) or through more global participation in the Tri-Services Aeromedical Research Panel, and the North American Treaty Organization (NAT0) Aerospace Medical Advisory Group.

Long-Range View

The Human Factors Research Program:

The FAA has accepted national responsibility to initiate and maintain research and development programs that support modernization, regulation, certification, and NAS issues, and, with equal importance, national responsibility to initiate research which is proactive in identifying emerging safety trends. The Human Factors investment strategy will directly support proactive research

efforts to identify and address targeted safety issues.

Baseline data will be established to show direct causal relationships between research outputs and accidents and incidents. Research programs will be directed at targets that have the greatest impact on aviation safety, will be multi-year efforts, and require stabilized resources to plan, execute, and complete. Successful implementation of research outputs will require full partnerships and close cooperation within FAA organizations and the aviation community.

Research strategies will focus on technology, partnerships, and measurements. For example, methods will be developed to identify interventions to address human performance issues in aviation maintenance and air traffic operations. With regard to partnership strategies, a five-year integrated safety research plan will be developed with NASA, addressing long-range, high pay-off priorities. Measurement strategies will be developed to accurately monitor trends and identify opportunities for research to mitigate risks.

Public and Congressional interest in the maintenance of a healthy and comfortable environment for each category of civil aviation's participants is not abating. The five-year interagency agreement between FAA and NIOSH initiated in FY97 addresses infectious disease and other health considerations in the aircraft cabin environment.

FAA goals related to preventing accidents and minimizing injury, associated pain, necessary rehabilitation, and death as a consequence of aviation accidents make the work of the Aviation Medicine Program a critical component of coordinated steps which will increase human survivability, which is one of the accepted corporate strategies for decreasing fatality accidents. The Aviation Medicine program will emphasize the reduction of accidents, and reduction in the severity of injuries encountered in such precautionary events as evacuation of passengers from an aircraft after recognition of a safety concern by the flight crew. This approach will cut rehabilitation time, decrease medical costs, and improve the quality of life for those who suffer injuries.

Additionally, in concert with the targets expressed in Challenge 2000 and with FAA's broad commit-

ments to harmonize safety regulations on a global scale, the Aviation Medicine Program will focus its collaborative interactions with domestic and international laboratories to generate research data to be used in the development of internationally harmonized aviation standards and regulations. Aeromedical research will be increasingly required to interpret data derived from around the world, and to assess whether the data are appropriate or require additional investigation prior to use in regulatory or other actions.

A08a Flight-Deck/Maintenance/System Integration Human Factors

GOALS:

Intended Outcomes: The FAA intends to improve air transportation safety by:

- Developing more effective methods for aircrew, inspector, and maintenance technician training.

- Developing more human-centered flight controls and displays.

- Increasing human factors considerations in certification of new aircraft and equipment design and modification.

- Improving aircrew, inspector, and maintenance technician task performance.

Agency Outputs: The FAA is concerned with ensuring the safety and efficiency of operator performance through guidelines, handbooks, advisory circulars, rules, and regulations. It provides industry with human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. The Human Factors Program conducts and manages research that provides the technical information necessary to generate these products and services.

Customer/Stakeholder Involvement: The Human Factors Program directly supports a number of aviation community initiatives:

- *FAA Strategic Plan Mission Goal for Safety.* By 2007, reduce U.S. aviation fatal accident rates by 80% from 1996 levels; ARA FY 2000 Performance Plan:

  – Goal 1. Contribute to the FAA goal to reduce the fatal aviation accident by 80% by 2007 as compared to 1994-1995 baseline data; and
  – Goal 2. By 2005, ensure human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications.

- The FAA/Industry *Safer Skies* initiative, which will use the latest technology to help analyze US and global data to find the root causes of accidents and determine the best ac-

tions to break the chain of events that lead to accidents.

- The *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application* published in March 1995, with FAA, NASA, and DOD as signatories. This document, which had extensive aviation community participation in its development, outlines a coherent national agenda for human factors research and application leading to significant improvements in NAS safety and efficiency.

- The FAA report entitled "The Interfaces Between Flight Crews and Modern Flight Deck Systems."

- Public Law 100-591, which establishes requirements for human factors research and its application.

- The Advanced Qualification Program (AQP), which has been adopted by every major US carrier, incorporating human factors training into pilot qualification and recurrent training programs.

- Crew Resource Management (CRM) training procedures, a variant of which has been adopted by virtually every major domestic air carrier.

Accomplishments: The program output of data packages, models, and regulatory documents include:

- Developed, and currently field-testing with several airlines, a prototype Automated Performance Measurement System (APMS) which allows for the gathering and analysis of data from aircraft flight data recorders. This information and analysis capability provides the backbone for the Flight Operations Quality Assurance Program, a joint FAA and airlines venture to enhance aviation safety.

- Provided proceduralized CRM guidelines for major and regional airlines.

- Validated human performance transfer functions for level-C full flight simulator.

- Developed a model AQP to support regional air carrier participation. AQP is a proficiency

based approach to pilot training that is considered to be highly effective and efficient for aircrew training.

- Developed the AQP database, incorporating user comments on the task analysis and task listing components, and incorporated a performance database which will link tasks to performance indicators.

- Provided air carrier training data analysis tools for quality assurance.

- Developed a system to allow air carriers to reconfigure FAA-approved flight scenarios to unique training segments, and developed a generic line-oriented evaluation event set database to be used by any air carrier.

- Developed a set of requirements for simulator motion for recurrent training.

- Initiated a comprehensive research program addressing cockpit automation.

- Developed a prototype certification Job Aid for FAR Part 25 flightdeck displays. This tool will be used by certification personnel and designers to address human performance considerations during the aircraft certification process.

- Published the *Aviation Maintenance Human Factors Guide.*

- Developed and implemented the Agency's first virtual collaborative research team to communicate and disseminate information in real time regardless of distance or other constraints on research team members.

- Developed (with industry) the first industry standard and guidance document on implementing an Aviation Maintenance Human Factors Program.

- Completed the Job Task Analysis of the Aviation Maintenance Technician Workforce.

- Developed the Aviation Maintenance Document Design Aid incorporating simplified English and utilizing advanced technology to standardize aviation maintenance documentation.

- Developed the Maintenance Resource Management (MRM) handbook for use by industry.

- Completed the prototype MRM distance learning project which will be implemented and used by the US Navy for training their Naval Aviation Maintenance Technicians. Further application can be applied to US Coast Guard Aviation Maintenance Technicians.

- Developed an Advisory Circular on Training, Qualification, and Certification on Nondestructive Inspection Personnel.

- Developed a prototype automated system of self-instruction for specialized training for the industry aviation maintenance inspector workforce.

- Developed guidance and recommendations on human factors best practices in fluorescent penetrant inspection. This project provided a more systematic view of human/system interaction.

- Developed guidance and standardized shift turn-over procedures for use in aviation maintenance.

- Provided educational outreach to the aviation community through the NASA/FAA fatigue countermeasures training module.

- Developed pilot performance profile, through flight simulation, for use in establishing certification standards for General Aviation auto-navigation and control systems.

- Developed aircraft certification human factors and operations checklist for stand alone global positioning system receivers.

- Developed a CD-ROM training program that guides General Aviation pilots through the creation of a personal checklist that incorporates minimum operating conditions and procedures based upon their own personal capabilities and experience.

- Developed a CD-ROM training program which describes the structured decision-making style of experienced General Aviation pilots compared to less experienced pilots. The program stresses situational awareness, diagnosis, resolution, and vigilance.

- Developed a CD-ROM training program which teaches General Aviation pilots to rec-

ognize the cues associated with deteriorating weather while in-flight, and to take appropriate action to avoid weather.

R&D Partnerships: Collaboration has continued between the FAA and industry partners to develop intervention strategies and reduce aviation accidents through the various Joint Safety Awareness Teams (JSATs) developed as part of the Safer Skies agenda. The human factors program is linked to NASA and DOD under the auspices of the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application.* Specific areas of coordinated program execution with NASA include cockpit automation, fatigue, CRM, team decision making, air- ground communication, and aviation maintenance. DOD joint efforts are in fatigue, team performance, decision making, aviation MRM, distance learning, and human error risk analysis. Additionally, the FAA is represented on the DOD Human Factors Engineering Technical Advisory Group, a forum for the coordination of research across a variety of technical areas. Members from the National Transportation Safety Board (NTSB) provided input to the human factors program in the areas of fatigue, flight deck automation, error mitigation, and aviation maintenance. Through aviation maintenance partnerships with industry, the FAA and industry are receiving real world applied research results. Aviation maintenance human factors is also working with other countries (such as Transport Canada) for globalization of aviation maintenance and inspection human factors. The FAA participates on all of the Society of Automotive Engineers G-10 human factors subcommittees related to human factors research areas, ensuring transition of the results to standards, guidelines, etc. The FAA also has extended grants to sixteen universities supporting research on air carrier training, flight deck automation, general aviation, and aviation maintenance technician and inspector training.

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

Selection and training.

- Provided industry and the FAA guidance addressing training crewmember use of advanced automated systems.

- Provided methods to integrate quantitative indices of operational performance data with pilot training data to evaluate the effectiveness of flight training programs, specifically AQP.

- Provided methods of employing scenario-based evaluation and analysis techniques to identify troublesome trends before accidents occur, and provide appropriate training technologies to remediate identified weaknesses.

Human performance assessment.

- Provided expanded APMS methodologies and analysis capabilities in order that air carriers can collect and analyze increasing amounts of flight and simulator data.

- Developed mapping of flight data parameters onto AQP qualification standards.

- Developed Human Factors Guidelines for Certification of Head-up Display for Air Transports, version 1.

- Provided initial pilot/controller shared separation performance requirements for Free Flight.

- Completed assessment of the utility of PC-based aviation training devices in maintaining General Aviation pilot instrument proficiency.

- Completed evaluation of the application of a comprehensive human factors analysis and classification system (HFACS) to air carrier and general aviation accidents.

Human-centered automation.

- Provided industry and FAA guidance addressing training for automated cockpits. These guidelines will encompass the performance difficulties associated with increased coupling, complexity, and autonomy of modern cockpit technology.

- Completed human factors certification Job Aid version 1 for FAR Part 25 flightdeck displays. This tool will be used by certification personnel and designers to address human performance considerations during the aircraft certification process.

- Completed human factors guidelines for assessing advanced general aviation transporta-

tion experiments (AGATE) cockpit controls/ displays.

Information management and display.

- Completed software tools for enhanced maintenance documentation.

- Developed preliminary version of Electronic Flight Bag usability evaluation tool.

- Developed General Aviation head-up display information/symbology recommendations.

- Completed Data Link lessons-learned compendium for inclusion in RTCA DO-238A, "Human Factors Requirements and Guidance for Controller/Pilot Data Link Communications Systems".

- Completed prototype human factors guidelines for the certification of head-up displays for air transports.

KEY FY 2001 PRODUCTS AND MILESTONES:

Selection and training.

- Report on antecedents to cockpit error in air carrier operations.

- Develop training guidelines for multi-tasking activities related to cockpit distractions.

- Survey results of air carrier pilots addressing AQP training effectiveness.

- Report on automated skills leading to training guidelines for automated cockpits.

- Draft prototype integrated CRM technical training program based on model AQP methodology.

- Develop training guidelines for air carrier pilot decision-making, addressing first officer's hesitancy to challenge the captain in potentially high risk situations.

- Produce modified reconfigurable event set scenario development system.

Human performance assessment.

- Refine flight and simulator data analysis tools.

- Report on the effectiveness of realistic radio communications in line-oriented evaluations.

- Define General Aviation pilot decision-making skills required for training module development.

- Provide expanded APMS methodologies and analysis capabilities in order that air carriers can collect and analyze increasing amounts of flight and simulator data.

- Develop improved human factors guidelines for aircraft accident investigation and reporting systems.

Human-centered automation.

- Provide industry and the FAA guidance addressing training for automated cockpits. These guidelines will encompass the performance difficulties associated with increased coupling, complexity, and autonomy of modern cockpit technology.

- Provide human factors evaluation for AGATE flight systems configurations.

- Develop certification guidelines for integrated technology in general aviation cockpits.

- Complete human factors certification Job Aid version 2.0 for FAR Part 25 flightdeck displays. This tool will be used by certification personnel and designers to address human performance considerations during the aircraft certification process.

Information management and display.

- Develop and implement guidelines for maintenance error investigating and reporting systems.

- Develop flight data recording and analysis capability for flight simulators.

- Complete Electronic Flight Bag usability evaluation tool.

- In response to the evolving requirements of AGATE, conduct comparative analyses to determine if any substantial degradation in visual search is concurrent with the presence and/or use of the head-up or head-down display, and which tasks benefit most from each type of presentation.

- Complete human factors guidelines for the certification of head-up displays for air transports.

FY 2001 PROGRAM REQUEST:

The program continues to focus on providing technical information and consultation to improve aircrew, inspector, maintenance technician, and aviation system performance. Emphasis is on developing guidelines, tools, and training to enhance error capturing and mitigation capabilities in the flight deck and maintenance environments; and on developing human factors tools to ensure that human performance considerations are adequately addressed in the design and certification of flight decks and equipment.

A08a - Flight-Deck/Maintenance/System Integration Human Factors Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
081-110 *Flightdeck/Maintenance/System Integration Human Factors*							
Selection and Training	$2,600						
Provide Methods to Integrated Performance Data with Pilot Training Data to Evaluate Flight Training		♦	◇	◇			
Develop Advanced Qualification Program (AQP) Database Incorporating User Comments		♦	◇	◇	◇	◇	
Provide Air Carrier Training Data Analysis and Tools Tailored to Scenario-Based Evaluation		♦	◇	◇	◇	◇	◇
Provide Industry and FAA Guidance Addressing Training Crewmember Use of Advanced Automated Systems		♦	◇	◇	◇	◇	◇
Report on Antecedents to Cockpit Error in Air Carriers		♦	◇				
Implement Advanced GA Training Techniques		♦	◇	◇	◇	◇	◇
Completed Guidelines for Maintenance Technician Situation Awareness Training		♦					
Human Performance Assessment	$700						
Provide Expanded Automated Performance Measurement System (APMS) Methodologies and Analysis to Collect/ Analyze Flight/Simulator Data		♦	◇	◇	◇	◇	◇
Develop Guidelines for Certification of Head-Up Displays		♦	◇	◇			
Develop Guidelines for Accident Investigation and Reporting		♦	◇				
Complete Research on Aviation Maintenance Error Reporting Systems		♦	◇	◇			
Human Centered Automation	$2,368						
Initiate/Coordinate Comprehensive Research Program Addressing Cockpit Automation		♦	◇	◇	◇		
Provide Preliminary Recommendations for Improved Training for Automated Flight Management Systems		♦	◇	◇	◇	◇	
Develop a Job Aid to Help Certification Personnel and Designers Assess Automated Flight Decks		♦	◇	◇			
Provide Industry and FAA Guidance Addressing Training for Automated Cockpits		♦	◇	◇	◇	◇	◇
Provide Industry and FAA Guidance to Effectively Address Cultural Influence on Crewmember Use of Automated Systems		♦	◇	◇			
Provide Human Factors Evaluation for Advanced General Aviation Transport Experiment (AGATE) Flight Systems		♦	◇				
Information Management and Display	$1,145						
Complete Software for Enhanced Maintenance Documentation		♦	◇				
Develop and Implement Guidelines for Maintenance Error Investigation and Reporting Systems		♦	◇	◇			
Complete Electronic Flight Bag Usability Evaluation Tool		♦	◇				
Develop Guidelines for Design/Certification of Head-Up Display for General Aviation		♦	◇	◇	◇		
Personnel and Other Costs	$3,287						
Total Budget Authority	**$10,100**	**$9,142**	**$10,100**	**$10,323**	**$10,600**	**$10,934**	**$11,330**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	8,430	10,365	8,497	6,289	7,038
Personnel Costs	2,048	1,814	1,940	2,367	2,283
Other Costs	420	371	563	486	779
Total	**10,898**	**12,550**	**11,000**	**9,142**	**10,100**

A08b Air Traffic Control/Airway Facilities Human Factors

GOALS:

Intended Outcomes: The FAA intends to:

- Address today's human factors problems associated with National Airspace System (NAS) transition and operational integration of decision support and other automation.

- Increase understanding of the human factors of emerging technologies, changing human roles and responsibilities, and evolving procedures, to help optimize human performance.

- Promote integration of human factors products into the development of advanced operational concepts that are based upon transitions in the NAS architecture.

- Develop enhanced measures of human performance and increase understanding of factors which can lead to performance decrements.

- Develop intervention and management strategies for fatigue and error.

Agency Outputs: Human factors problems in today's operations involve human performance considerations and human factors issues in the acquisition of Air Traffic Control (ATC) systems. The study of the relationship between shiftwork schedules and fatigue is identifying techniques for mitigating impacts on controller performance. Taxonomic analysis of operational errors is identifying improvements in how errors are investigated and reported, which in turn is leading to more effective interventions. Human factors research provides guidelines and other information for the design and development of ATC systems and product improvements. Research products are shared with the aviation community via the World Wide Web. Research and development products include:

- Models of performance and efficiency based on system variables.

- Development of workload, performance, and decision-making measures and models for existing systems and new technologies.

- Human/system productivity enhancement technology.

- Tests and criteria for selecting operational personnel.

- Recommendations for the design of operational facilities and control rooms.

- Guidelines and recommendations for minimizing sources of error and fatigue.

Customer/Stakeholder Involvement: The ATC/Airways Facilities (AF) Human Factors Research Program is the product of continued cooperation and collaboration between the Office of the Chief Scientific and Technical Advisor for Human Factors (AAR-100) and its customer base, the Air Traffic Requirements Service (ARS). Details of the research portfolio are coordinated with the following organizational elements of ARS: Plans and Performance Directorate (ARX-20); Resource Management Program (AFZ-100); NAS Operations (AOP-30); and Air Traffic Procedures (ATP-400). In addition, organizational elements of the Office of Communication, Navigation, and Surveillance Systems (AND), and the Office of Air Traffic Systems Development (AUA) share in research planning through the medium of AAR-100 representatives which reside within those organizations. Also represented is the Offfice of System Architecture and Investment Analysis (ASD-130) which offers input and with whom research projects are frequently coordinated.

Human Factors research is grounded in the human factors issues that emerge from FAA's ongoing transition to new concepts of operation. The 2005 Concept of Operations states: "the NAS in 2005 takes a human-centered approach to maximize the efficient delivery of air traffic services to users. Thus, system processes and workstations are designed to expedite the exchange of information between NAS information systems, service providers, and users. Human factors analyses and human-in-the-loop simulations have determined the appropriate allocation of tasks between service providers, users, and automation systems. Moreover, issues such as situation awareness, workload, and computer-human-interface (CHI) design have been resolved by incorporating human factors. This approach ensures that the human capabilities and limitations of users and service providers remain a primary consideration in systems development. The evolution of the NAS utilizes a clear transition strategy for each operational capability, and employs a human-cen-

tered approach for implementing new operational concepts and supporting technologies".

The program also draws on NAS Architecture Version 4.0 which specifies: "a broad range of research activities regarding the implications of human factors. These research activities will acquire and then apply the information necessary to understand human capabilities and limitations in each functional area. Human factors engineering will then be applied to identify and resolve risks, and to assess costs, benefits, and trade-offs".

The ATC/AF Human Factors Research Program is also responsive to the recommendations of the congressionally mandated Research, Engineering, and Development Advisory Committee (REDAC). Among REDAC recommendations are suggestions to "Increase emphasis on understanding the implications of various Free Flight architectural alternatives on pilot and controller performance, and incorporate this understanding early in the NAS architecture evolution process". Some of the human performance issues that appear to be important to "Free Flight" and are factored into planning the research portfolio include:

- Distribution of Air/Ground responsibility.

- Strategies and technologies used by controllers to organize traffic.

- Ability of controllers to deal with flexible airspace (e.g., dynamic resectorization).

- Monitoring and out-of-loop issues for pilots and controllers.

- Trust in automation.

- Conflict resolution strategies.

- Collaborative decision making behavior.

- Gaming behavior on the part of pilots, airlines and controllers.

- Shared situational awareness.

- Intervention strategies.

- Communication requirements.

- New strategies for error assessment in a collaborative environment.

In addition, research planning is directly tied to the following ARA Performance Goals:

Goal 1. Safety: In support of the FAA's mission goal related to system safety, contribute to the FAA goal to reduce the fatal aviation accident rate 80% by FY 2007 as compared to 1994-1996 baseline data.

Goal 2. Human Factors: In support of FAA's performance goals, ARA will, by 2005, ensure human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications. Two strategies have been identified to ensure that human factors are addressed in the research and acquisition of 100% of FAA aviation systems and applications. These strategies cover human factors activities associated with the study, analysis, research, design, development, testing, deployment, and implementation of FAA systems and applications.

Central to this research program, as well as other research efforts conducted by AAR-100, is its emphasis on the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*. This document, published in March 1995, with FAA, NASA, and DOD as signatories, had extensive aviation community participation in its development, and outlines a coherent national agenda for human factors research and application leading to significant improvements in NAS safety and efficiency.

Accomplishments: The program has performed or sponsored the following research with resulting products:

- Developed database of air traffic control performance measures.

- Basic Electronic Specialist Test (BEST) - Improved screening test for selection of AF new hires, with an estimated savings of $3-5 million/year in reduced training costs.

- Variable Item Generator (VIGOR) – This enhances the reliability of the BEST test by mitigating coaching or practice effects.

- Post Operations Evaluation Tool (POET) – Developed a software product that contributes to ATM collaborative decision-making.

- Flight Service Station Operational and Supportability Implementation System (OASIS) Study – Conducted virtual reality ergonomic evaluation of proposed Flight Service Station workstations.

- Database of Air Traffic Control Specialist (ATCS) Field Work Schedules – Completed first element of Congressionally mandated study of controller shiftwork, fatigue, and performance.

- Enhanced Visual Scanning Methodology - Adapted technology for integration with the 2005 Concept of Operations simulation studies.

- Impact of Shared Separation on ATCS Situation Awareness – Conducted study of free flight impact on air traffic controllers' performance.

- Guidelines on use of Color in ATC Displays – This provides Integrated Product Teams (IPTs) with reference information on the most effective uses for color in new system displays.

- Future Controller Selection – Developed prototype methodology to evaluate the impact of technological and Concept of Operations change on controller selection requirements.

- Auditory Alarm Database – Developed extensive database of alarms applicable to the design of alerting systems for AF in future centralized maintenance and control centers.

- Aviation Safety Reporting System Pilot-Controller Communications – Prepared analysis of data concerning occurrences of pilot-controller miscommunication.

- Multi-sector ATC Teamwork Simulator - Developed and delivered to the FAA Academy for use in Air Traffic Team Enhancement Program (ATTEP).

- Standard Terminal Automation Replacement System (STARS) - Conducted comprehensive assessment of the STARS operational radar display and maintenance control workstations. Identified a significant number of human factors issues which were resolved through a work group comprised of human factors, ATS, STARS program office, NATCA, Raytheon, Mitre and other stakeholders. A notable product was a definitive process to integrate human factors in other NAS acquisitions.

- Air Traffic Controller Selection - Collaborated with ATS to develop new selection instrument for air traffic controllers.

- National Research Council (NRC) Study - Sponsored the NRC assessment of human factors issues in the air traffic control system. Under this grant, the NRC briefed the FAA and Congress and published two books, *Flight to the Future - Human Factors in Air Traffic Control*, and T*he Future of Air Traffic Control*.

- Systematic Air Traffic Operations Research Initiative (SATORI) - Completed development of enroute SATORI, a research and accident investigation tool installed in all Air Route Traffic Control Centers.

- Airway Facilities Maintenance Study - For the Airway Facilities Operations Management Team, measured taskload and documented work processes of personnel at present Maintenance Control Centers (MCCs).

R&D Partnerships:

NASA, DOD, and FAA are cooperative partners in the development and execution of *the National Plan for Aviation Human Factors: An Initiative for Research and Applicatio*n. Coordinated research efforts are conducted with NASA Ames in the areas of free flight and shift work induced fatigue and associated countermeasures. Additionally, elements of the controller performance research project are conducted in concert with the USAF's Armstrong Laboratory and the US Coast Guard R&D Center. Internationally, research on development and validation of controller applicant selection methods is shared between project leaders in this program and their functional equivalents in Sweden, Denmark, Australia, Great Britain, and other EUROCONTROL countries.

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

- Congressionally mandated assessment of the minimum English language proficiency required of controllers in other countries.

- High-fidelity computational models of human performance with larger scale models of NAS operation.

- Comprehensive database of ATC performance baselines and metrics.

- Report on the impact of dynamic airspace restructuring on air traffic controller performance.

- Report on workload issues associated with conflict probe.

- Assessment of the impact of conflict probe and Controller-Pilot Data Link Communications on Air Route Traffic Control Center sector team performance.

- Taskload and performance measurement pre- and -post Display System Replacement (DSR) implementation.

- Assessment of air traffic controller separation strategies.

- Initial results of using bright lights as a fatigue countermeasure.

- Strategic job analysis determining changes in controller knowledge, skill, and abilities associated with emerging technologies.

- Strategies for human error prevention/mitigation in AF maintenance control centers.

- Identification of impacts of alternative work schedules on controller performance.

- Enhanced capability to recreate operational incidents using recorded data from the DSR.

- Benchmarking of best practices and lessons-learned regarding implementation of enterprise asset management systems for Airway Facilities.

KEY FY 2001 PRODUCTS AND MILESTONES:

Research to be conducted will impact a wide variety of ATS programs. To facilitate understanding, these efforts are grouped into the following research thrusts previously identified in the National Plan:

Information Management and Display

- Reduction of paper flight progress strips. Refinements to automation, procedures and training to facilitate reducing the operational need for paper flight progress strips will be developed.

- Resolving human factors issues in controller/pilot data link communications. Information coding techniques for enhanced future ATS displays will be examined.

- Use of color in ATC alerting. Efficacy of display coding techniques for information alerting will be explored.

- Information management in future AF systems. The goal of this task is to determine how to optimize information transfer and display to support operator and team performance in the AF environment.

- ATC emulation prototypes and simulator development. The FAA is fielding STARS and the DSR to modernize the terminal and en route air traffic control systems. These systems will provide the infrastructure for future ATC functionality and advanced ATM concepts. The FAA is developing emulation prototypes of each of these systems. These prototypes will provide a rapidly reconfigurable environment to demonstrate advanced ATC concepts and functionality. Further, the prototypes will be integrated with the existing Target Generation Facility to provide a high fidelity simulation environment to operationally validate concepts and conduct essential ATC research for NAS modernization.

- Update of Human Factors Design Guide (HFDG). This update of the HFDG includes integrating newer scientific design information for the computer-human interface, automation, and other sections.

- Identification and display of ATC complexity factors. Develop graphic displays of factors related to ATC complexity. Simulation studies with ATCSs will be conducted to assess the effectiveness of proposed display designs.

Human Centered Automation

- Controller Decisionmaking. Baseline measures of controller decisionmaking will be developed and evaluated. Alternative methods for displaying decision support information will be assessed.

- Situational awareness in centralized monitor and control. This research will determine what information and feedback is necessary for the operators to stay aware of automated processes and what implications the changing technology will have on situational awareness, workload, and performance.

- Conflict probe study. This project will use human-in-the-loop simulation to investigate how human operators use conflict probe tools in enroute airspace.

Human Performance and Assessment

- Human performance modeling integration. This research will integrate high-fidelity computational models of human performance with larger scale models of NAS operation, and will leverage data from human-in-the-loop simulation studies.

- Error mitigation. The goal of this research is to identify potential sources of human error and investigate strategies to mitigate their occurrence or severity.

- POWER taskload and performance baseline assessments. A set of numerical measures based on available recorded radar data will be developed to assess controller taskload as well as controller and system performance. The resulting measures will be used to baseline levels of taskload and performance at en route facilities. Data for facilities receiving DSR in this time frame will be collected and analyzed to compare taskload and performance before and after DSR implementation.

- Flight Planning. This research makes a detailed account of the opportunities and requirements for, and constraints upon collaborative decisionmaking about the filing and rerouting of flight plans for commercial aircraft.

- Boundary adjustment research. This study will apply real time human-in-the-loop simu-

lation to examine these issues. Current enroute controllers will participate in this study.

- Traffic demand prediction. This initiative will document information requirements for predicting traffic demand for sectors, and ascertain and document the information a Traffic Management Specialist needs, the sources of that information, and corollary knowledge used to make accurate predictions of traffic demand.

- Team processes in centralized monitor and control systems. This task will evaluate team and organizational concepts for relevance to AF. The result will be AF guidelines to enhance effective team operations in centralized monitor and control environments.

- Understanding expert ATC performance. This project will apply techniques from research on expertise to the ATC domain. Models of ATC performance, as well as objective metrics of cognitive performance, will be developed from this research. The objective measures will be applied to baselining performance in the current system and providing a knowledge base for optimizing transition to future systems. In addition, the FAA will identify opportunities to enhance cognitive performance in training.

- Baseline assessment of ATC teamwork and collaborative decision making. This project focuses on developing baseline information on coordinated decision making for the R-side and D-side controllers in the en route environment, and for terminal radar approach controllers.

- Examination of causal factors related to situational awareness. This project is targeted at reducing operational errors and deviations through the understanding of causal factors.

- Shift work and fatigue. This research is designed to evaluate the effectiveness of specific countermeasures for preventing shift work-related fatigue. The interaction of fatigue with age will be investigated.

- Human factors brochure for controllers. This brochure will provide controllers with helpful information about human factors they can use to enhance on the job performance.

- Complete DSR revisions of SATORI. SATORI enhancements are needed to read and analyze DSR recorded data.

Selection and Training

- Develop and validate computerized application evaluation systems. These systems will provide a tool for evaluating large number of applicants quickly and efficiently against qualification standards.

- Develop and validate computer-based selection tests. This project entails developing technical refinements to and conducting longitudinal validations of prototype modular, computer-based selection tests for near-term hiring into the ATCS, Electronic Technician, and Air Traffic Service Specialist occupations.

- Develop a prototype workforce analysis application. This tool will support the identification, description, and analysis of gaps between current and future workforce knowledge, skills, and abilities, and staffing profiles in the NAS architecture.

FY 2001 PROGRAM REQUEST:

The FY 2001 research program reflects a heightened emphasis on working with ATS to more fully address the pressing human factors issues that pose operational and maintenance risks for successfully fielding new technologies and procedures (such as Free Flight and Airway Facilities Operational Control Centers) over the next several years. Research projects focus on providing timely information to answer critical human factors questions associated with how these new systems and procedures will change human roles and responsibilities and consequent baseline changes to workload, situation awareness, error, and other performance attributes. Human factors research will ensure that human performance within this ever evolving and increasingly complex NAS is continually optimized to ensure effective human-system integration.

A08b - Air Traffic Control/Airway Facilities Human Factors Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
082-110 Air Traffic Control/Airway Facilities Human Factors							
Selection and Training	$670						
Develop/Validate Computerized Application Evaluation Systems		♦	◇				
Develop/Validate Computer-Based Selection Tests		♦	◇	◇			
Develop Prototype Workforce Analysis Application		♦	◇	◇			
Human Performance Assessment	$1,000						
Research Boundary Adjustment		♦	◇	◇	◇	◇	
Integrate Human Performance Modeling		♦	◇	◇	◇	◇	◇
Team Processes in Centralized Monitor/Control Systems		♦	◇	◇			
Mitigate Errors		♦	◇	◇	◇	◇	◇
Predict Traffic Demand		♦	◇	◇	◇	◇	◇
Display System Replacement (DSR) of Systematic Air Traffic Operations Research Initiative (SATORI)		♦	◇				
Effects of DSR Implementation and Transition Training		♦	◇	◇	◇		
Shift Work and Fatigue		♦	◇	◇	◇		
Baseline Assessment of Air Traffic Control (ATC) Teamwork/ Collaborative Decision-Making		♦	◇	◇			
Human Centered Automation	$1,300						
Situational Awareness in Centralized Monitor/Control		♦	◇	◇			
Controller Decision-Making		♦	◇	◇	◇		
Identification and Display of ATC Complexity Factors		♦	◇	◇	◇		
Conflict Probe Study		♦	◇	◇	◇		
Controller/Aircraft Separation Strategies		♦	◇	◇	◇	◇	◇
Information Management and Display	$1,275						
Information Management in Airway Facility Systems		♦	◇	◇	◇	◇	◇
Reduction of Paper Flight Progress Strips		♦	◇	◇	◇		
Information Coding Techniques for Enhancement of Future Air Traffic System (ATS) Displays		♦	◇	◇	◇	◇	◇
Efficacy of Display Coding Techniques for Information Alerting		♦	◇	◇			
Personnel and Other Costs	$5,705						
Total Budget Authority	$9,950	$8,000	$9,950	$10,293	$10,678	$11,112	$11,595

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	4,356	5,454	5,711	1,661	4,245
Personnel Costs	3,258	3,773	3,117	5,034	3,984
Other Costs	722	773	1,172	1,305	1,721
Total	8,606	10,000	10,000	8,000	9,950

A08c Aeromedical Research

GOALS:

The FAA safety mission dictates that:

- Existing injury and death patterns in civilian aviation accidents be meticulously reviewed.

- Recommendations for protective equipment and procedures be developed.

- Options be evaluated on behalf of FAA regulatory and medical certification staff charged with the proposal of safety regulations addressing all aircraft cabin occupants.

A concurrent mission is the identification of pilot, flight attendant, and passenger medical conditions that are incompatible with in-flight clinical and physiological demands on the occupant, both in the absence and presence of emergency flight conditions.

Intended Outcomes: The outcomes addressed by this research program are improved health, safety, and survivability of aircraft passengers and aircrews. This research program identifies human failure modes (physiological, psychological, clinical) both in uneventful flight, and during aircraft incidents and accidents. Formal recommendations for counteracting measures and techniques are derived from in-house research.

The FAA is able to develop new and evaluate existing bio-aeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments as a base for new regulatory action and the evaluation of existing regulations to enhance appropriate human performance at a minimum cost to the aviation industry. By reviewing pilot medical histories, flight histories, information from accidents and incidents, and existing/ new medical criteria, standards and assessment/ certification procedures can be proposed to ensure full performance capability at a minimal cost to the aviation industry. By assessing flight attendant and passenger environmental, behavioral, and disease issues, guidelines for actions to improve the health and safety of the aircraft occupant can be rationally proposed.

Agency Outputs: The program has developed the following criteria for use in regulatory and certification processes:

- Quantitative bioengineering criteria to support aircraft seat and restraint system certification.

- Quantitative biomedical criteria to support protective breathing equipment and operational procedures certification.

- Quantitative biochemical and toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits.

- Quantitative biomedical criteria to support flotation and onboard rescue equipment certification.

- Identification of medical/toxicological factors and human factors in aviation incidents and accidents.

- Recommendations for aircrew medical criteria, standards, and assessment/certification procedures.

- Quantitative data about the occupational health risks of flight attendants to support regulatory oversight.

- Quantitative data about passenger and aircrew behavior and health to support regulatory oversight.

Customer/Stakeholder Involvement: This program contributes to meeting the FAA Strategic Plan Mission Goal for Safety and ARA FY 2000 Performance Plan Goals for Safety and Human Factors. The program provides the primary bio-aeronautical research (note: defined as the bioengineering, biomedicine, and biochemistry issues associated with safety and performance) called for in the *National Plan for Civil Aviation Human Factors*. This program contributes significantly to the application of emerging technologies, as highlighted in the FAA Aviation Safety Plan. The program is an integral participant and research provider under the FAA, Joint Aviation Authorities (JAA), and Transport Canada Aviation (TCA) Aircraft Cabin Safety Research Plan established in 1995 as a coordinated, living plan to maximize the cost-benefit of aircraft cabin safety research internationally.

International Civil Aviation Organization (ICAO) initiatives addressing the health of the aircraft occupant (crew and passenger) are developed under this program before final FAA recommendations are provided to ICAO. This program is the only research component of the FAA that can legally access confidential medical data about pilots for use in epidemiological research studies approved by FAA's institutional review board for use of human test subjects. Multi-year collaborative studies performed by the FAA and National Institute for Occupational Safety and Health (NIOSH) into flight attendant and passenger symptomatology and diseases are funded by this budget item to satisfy the mandate placed by Congress upon the agencies in the FY 1994 Appropriation Act.

Accomplishments: Based on aeromedical research at the Civil Aeromedical Institute, the FAA issued an advanced notice of proposed rulemaking concerning the usage and design of child restraints on aircraft. The output of this program's research is permitting the FAA and National Highway Traffic Safety Administration to revise the testing requirements in Federal Motor Vehicle Safety Standard 213, which covers the design of child restraints for use in aircraft. Quantitative data were provided regarding various prototypes of aircraft-specific child restraints being developed as commercial products targeted for airlines. Specialized quantitative crashworthiness assessments for aircraft continued, inclusive of side-facing aircraft seats, and included the use of new state-of-the-art anthropomorphic test dummies with enhanced injury assessment capabilities.

Data are continuously provided to the research sponsor on the role of toxicological and clinical factors associated with each aircraft accident and significant incident. Current findings indicate that about one of six pilots fatally injured in a civilian aircraft accident show evidence of using a prescription drug; one of four has taken an over-the-counter drug; one of 25 has ingested significant positive alcohol; and 1 of 20 is using a significant controlled dangerous substance. Long-term aviation forensic and epidemiological research has helped the FAA to identify human factor roles in accident/incident causation. Specialized clinical evaluations were applied to cases associated

with aircraft decompression. Probable seizures and other factors indicative of sudden pilot incapacitation were evaluated.

R&D Partnerships: Several of these partnerships (e.g., FAA/JAA/TCA; FAA/NIOSH) have been referenced in the Customer/Stakeholder Involvement and Accomplishments sections above.

In addition, in each of the program area output categories, the FAA maintains direct cooperative research processes with all the manufacturers responsible for the safety products enumerated (seats, restraint systems, oxygen masks, evacuation slides, etc.). FAA investigators also maintain memberships on every Society of Automotive Engineers committee addressing safety research conducted under this program. The agency maintains a liaison with the American Society of Heating, Refrigeration, and Air Conditioning Engineers committee addressing aircraft cabin air quality status and research. Besides the active involvement in the FAA/JAA/TCA process of oversight for safety research, participants in this program are represented on appropriate subgroups of organizations such as the Aerospace Medical Association, the Civil Aviation Medical Association, and the Professional Aeromedical Transport Association. Close liaison with the military is maintained either through direct project collaboration (e.g., eye injury from lasers, crashworthiness) or through the more global participation in the TriServices Aeromedical Research Panel or North Atlantic Treaty Organization aerospace medical advisory groups.

MAJOR ACTIVITIES & ANTICIPATED FY 2000 ACCOMPLISHMENTS

The following program results have been achieved or are expected to be achieved in FY 2000:

- Performed epidemiological assessment of toxicology factors from fatal civilian aviation accidents.

- Developed guidelines for the use of AEDs on commercial aircraft.

- Evaluated autopsy data from fatal aviation accidents to determine protective equipment and design practices.

- Assessed flight attendant reproductive health hazards (Congressionally requested FAA-NIOSH study).

- Developed a rational performance-based standard for crew protective breathing and vision equipment (CPBVE).

- Proposed changes to regulations for operational hazards of laser exposure.

KEY FY 2001 PRODUCTS & MILESTONES

The following program results are being scheduled in FY 2001:

- Conduct epidemiological assessment of toxicology factors from fatal civilian aviation accidents.

- Determine the impact of new antihistamines on pilot performance.

- Develop guidelines to reduce in-flight sudden/subtle incapacitation.

- Evaluate autopsy data from fatal aviation accidents to determine protective equipment and design practices.

- Provide guidelines for aircraft cabin occupant health maintenance.

- Determine optimum wide-body exit distribution and access using new wide body evacuation simulator.

- Develop improved fit and comfort standards for oxygen mask systems.

- Evaluate pilot reported medication usage with actual toxicology findings to determine the accuracy of self reporting.

FY 2001 PROGRAM REQUEST:

The Office of Aviation Medicine encounters complex medical decisions during the initial and follow-up medical assessments of airmen who request special medical issuances (e.g., cardiac conditions, neurological deficits, etc.) to permit their continued flying. The prospective epidemiological assessment of special issuance methodology and medical outcomes in the airman population is required to ensure that medical issuances do not result in unexpected or increased aircraft accident or incident rates or risks.

Ongoing research projects will:

- Develop safer aircraft cabin evacuation approval guidelines and safer field applications under operational conditions.

- Reduce head, neck, and extremity injuries in aircraft crash environments.

- Evaluate trends in toxicology and clinical findings from all major civil aviation aircraft crashes.

- Develop guidelines for aircraft cabin crew and passenger environmental management.

A08c - Aeromedical Research Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
086-110 Aeromedical Research							
Cabin Health and Environmental Guidelines							
Assess Flight Attendant Reproductive Health Hazards		◆	◇	◇	◇		
Report on Guidelines for Aircraft Cabin Occupant Health Maintenance		◆	◇	◇	◇	◇	
Develop a Model of Disease Transmission Via Aerosols in an Aircraft Cabin Environment		◇					
Human Protection/Survival in Civil Aviation							
Analyze the Suitability for Component Tests as an Alternative for Showing Regulatory Compliance with Crashworthiness Standard for Aircraft		◆	◇	◇	◇		
Assess Impact Protection Performance of Aircraft Seating Systems, Including Child Restraints		◆	◇	◇	◇	◇	◇
Develop Performance-Based Narrow and Wide Bodied Aircraft Cabin Evacuation Approval Guidelines		◆	◇	◇	◇	◇	◇
Report on Suitability of Aircraft Cabin Evacuation Modeling as a Partial Replacement for Evacuation Tests with Human Subjects		◆	◇	◇	◇		
Evaluate Dual Aisle Evacuation Model						◇	
Develop Improved Oxygen Mask Fit and Comfort Standards		◆	◇				
Analyzed the Influence of Cabin Crew Duty Stations on Evacuation Performance of Passenger Aircraft in Panic Situations		◆					
Survey Parents Flying With Small Children on Their Likelihood to Divert to Other Modalities if Child Restraints are Required			◇				
Develop Standards for Protective Breathing Equipment				◇			
Medical/Toxicology Factors of Accident Investigations							
Perform Epidemiological Assessment of Toxicology Factors from Fatal Civilian Aviation Accidents		◆	◇	◇	◇	◇	◇
Develop Guidelines to Reduce In-flight Sudden/Subtle Incapacitation		◆	◇	◇	◇	◇	◇
Compared Toxicology Findings at Time of Flight Physical to Post-Accident Data		◆					
Evaluate Autopsy Data from Fatal Aviation Accidents to Determine Protective Equipment and Design Practices		◆	◇	◇	◇	◇	◇
Reported on the Impact of the Drug Abatement Program on Aviation Accidents/Incidents		◆					
Develop Toxicological Test to Distinguish Between Ingested and Post-Mortem Alcohol						◇	
Survey of In-flight Medical Emergencies and Defibrillator Usage on Commercial Airline Flights			◇				
Determine Impact of Hypoxia on the Metabolism of Antihistamines			◇				
Personnel and Other Costs	**$5,049**						
Total Budget Authority	**$5,049**	**$4,829**	**$5,049**	**$5,322**	**$5,610**	**$5,912**	**$6,231**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	0	0	313	394	0
Personnel Costs	3,320	3,320	3,155	3,858	3,893
Other Costs	680	680	597	577	1,156
Total	**4,000**	**4,000**	**4,065**	**4,829**	**5,049**

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